

TAXONOMIC REVISION OF THE GENUS *GAGEA* SALISB. (LILIACEAE) IN INDIA AND ADJOINING REGIONS¹

SYAMALI DASGUPTA AND D. B. DEB²

(With four text-figures)

Taxonomic revision of the genus *Gagea* Salisb. (Liliaceae) in India and adjoining regions comprising 12 species and 1 extra-typical variety including 1 new species is presented in this paper.

5 species hitherto known as distinct have been reduced to synonymy and 1 to a variety. 5 species are reported for the first time for this region.

Taxa are described with synonyms, original citations, and types. Key to the species is given. Distribution and phenology of the taxa are traced. Exsiccata studied are cited.

INTRODUCTION

Salisbury (1806) separated 7 species so long placed in the genus *Ornithogalum* by Linnaeus (1753, 1754), Pallas (1773, 1776), Schmidt (1794), Willdenow (1799), for their "distinction in habit and fructification". He named the new genus *Gagea* after Sir Thomas Gage who was indefatigable in collecting rare European plants and was liberal in distributing them. This genus differs from *Allium* and allied genera in the absence of involucre of bracts.

Reichenbach (1828) did not accept this generic status but retained it as subgenus under *Ornithogalum* in the tribe *Scilleae*. Schultes (1829) accepted the generic distinction and placed the genus near *Ornithogalum* in the tribe *Asphodelae*. Link (1829) proposed the generic name *Ornithoxanthum* for some of the species placed by Salisbury in his *Gagea*. Lindley (1836) merged *Ornithoxanthum* Link with *Gagea*. Lindley (l.c.), Kunth (1843),

Bentham (1883), Boissier (1882) and Hutchinson (1973) placed the genus under the tribe *Tulipeae* whereas Endlicher (1836) placed it under suborder *Tulipaceae* near the genera *Tulipa* and *Lloydia* for basifixed laterally dehiscent anthers. Baker (1874) removed the genus from the tribe *Tulipeae* for the absence of leaf on the scape and umbel inflorescence but did not deal with it subsequently. For the same reason Engler (1888), Krause (1930) and Grossheim (1935) placed it near *Allium* in the subfamily *Allioideae*. In the meantime, some new genera namely *Hornungia* Bernhardt (1840), *Bubillaria* Zuccarini (1843), *Plectostigma* Turczaninow (1844), *Solenarium* Dulac (1867) allied to *Gagea* were described separating some species from the existing genera or for accommodating newly described species. These genera have later been merged with the genus *Gagea* by subsequent workers like Engler (l.c.) and Krause (l.c.).

Salisbury (1806) while publishing the genus *Gagea* did not indicate the type species. Of 7 species he considered for this genus two

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² Botanical Survey of India, Howrah.

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were described by Linnaeus (1753) of which *G. minima* (L.) Ker-Gawl. is more representative of the generic description particularly in "Flores corymbosis. Pedunculus . . . plus minus decompositus . . ." and is therefore selected as the lectotype of the genus.

This revision is based on study of specimens extant in CAL, BSIS, BSD, DD, LWG, K, BM, L, G.

Gagea Salisb. in Konig & Sims, Ann. Bot. 2: 555. 1806; Kunth, Enum. Pl. 4: 233. 1843; Benth. in Benth. & Hook. f. Gen. Pl. 3: 819. 1883; Boiss. Fl. Or. 5: 203. 1882; Engl. in Engl. & Prantl, Nat. Pflanzenfam. Teil. 2. Abt. 5: 60. 1888; Hook. f. Fl. Brit. Ind. 6: 355. 1892; Collett, Fl. Simlens. 529. 1902; Krause in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 15a: 318. 1930; Grossh. in Komarov, Fl. U.S.S.R. 4: 61. 1935; Hutchins. Fam. Fl. Pl. 754. 1973. *Ornithoxanthum* Link, Handb. 1: 161. 1829. *Hornungia* Bernh. Flora 23: 392. 1840 (Type: *H. circinata* Bernh.). *Bubillaria* Zucc. in Pl. Hort. Bot. Moench. 3: 229. t. 2. 1843 (Type: *B. gageoides* Zucc.). *Plectostigma* Turcz. in Trautv. Pl. Imag. Fl. Ross. 9. t. 2. 1844 (Type: *P. pauciflorum* Turcz.). *Boissiera* Haenseler ex Willkomm & Lange, Prodr. Fl. Hisp. 1: 218. 1861. *Solenarium* Dulac., Fl. Hautes Pyr. 117. 1867.

Lecto type: *Gagea minima* (L.) Ker-Gawl. (Linn 428.3 LINN).

Herbs gregarious, 5-22 mm long, bulbous; bulbs small, ovoid, formed of single fleshy radical leaf base and 1 or 2 concentric reduced previous radical leaf bases, outer scales scarious or fibrous; bulbels 1, 2 or numerous. *Radical leaf* 1 or 2, about as long as the inflorescence, lanceolate, linear or terete. *Stem* terete, glabrous, leafy at the base of the inflorescence or all over. *Cauline leaves* 1 to many, lanceolate or linear, passing to bracts above,

often with 1 to many bulbels at the axils. *Inflorescence* terminal, corymbose or scorpioid cyme or umbel, sometimes flowers solitary. *Flowers* 5-15 mm long, campanulate; pedicel varies in length; bracts small, linear, at the base of the pedicels or branching of the peduncle. *Perianth* biseriate, yellow inside, glossy, rarely whitish outside with a broad green band, sometimes reddish or dark purple, persistent to fruit, more or less indurulent and accrescent, lanceolate or oblanceolate, acute or obtuse; veins parallel, diverging. *Stamens* 4-9 mm long; filaments linear or subulate, attached at the base of the perianth; anthers globose or oblong, basifixed, latrorse. *Pistil* 4-11 mm long; ovary sessile or stipitate, obovoid to oblong, trilobed; style as long as or longer than ovary, triquetrous; stigma truncate, trilobed. *Capsules* 4-8 x 3-6 mm, broadly obovoid, trilocular, trilobed with persistent perianth. *Seeds* many, deep brown, 1.3 x 1-1.5 mm, triquetrous or semirotund, compressed or not, wingless.

Distribution: 70 species are distributed in temperate Eurasia (Airy Shaw 1973). 12 species and 1 extratypical variety are distributed in Afghanistan and Pakistan in the west through Kashmir, Nepal to Sikkim in the east (Fig. 1).

RANGE OF VARIATION

1 or 2 bulbels develop at the axil of the radical leaf as in *G. anisanthos*, *G. toppinii*, *G. reticulata*. In some cases large number of bulbels are produced inside the mother bulb, such as *G. lutea*, *G. improvisa*, *G. persica*. Radical leaf is generally solitary, in some species as in *G. anisanthos*, *G. toppinii*, there are two radical leaves by the germination of one bulbel. Radical leaves vary from linear to



Fig. 1. Map showing distribution of *Gagea* Salisb. in India and adjoining region.

lanceolate or broadly lanceolate. It is linear in *G. improvisa*, *G. anisanthos*, *G. toppinii*, *G. reticulata*, *G. setifolia*, *G. olgae*, *G. bulbifera*; lanceolate to broadly lanceolate in *G. lutea*, *G. kunawarensis*, *G. persica*. In addition to radical leaves there are cauline leaves which can be distinguished from bracts in *G. persica*, *G. kunawarensis*, *G. anisanthos*, *G. improvisa*, *G. toppinii* and *G. lutea*. Lower part of the stem is mostly naked, and cauline leaves are formed in the upper part below the inflorescence. But in *G. pamirica*, and *G. bulbifera*, stem is leafy throughout. Cauline leaves are gradually smaller towards the inflorescence and change to bracts. It is lanceolate or linear and parallel-veined.

Inflorescence of *Gagea* varies from species

to species. In some species inflorescence is a corymbose panicle with repeatedly branching peduncles, distinct internodes and solitary bract at the point of ramification, as in *G. minima*, *G. persica*. Compound corymb is reduced to simple raceme in *G. bulbifera* where internodes are distinct and pedicels are long. Next stage of reduction has taken place in the internodes. Longer and older pedicels are close to the younger shorter ones by reduction of the internodes above and form a condensed scorpioid cyme, looking like a fascicle as in *G. lutea*. Further reduction in this direction has led to formation of the umbel in *G. reticulata*. Umbel with older flowers below and young ones above shows its affinity with *Allium*.

Perianth is yellow with green outside in *G. lutea*, *G. reticulata*, *G. setifolia*, *G. improvisa* etc., yellow with brownish outside in *G. olgae*, and green in *G. bulbifera*. Perianth lobes are broadly lanceolate with obtuse apex in *G. lutea* or lanceolate with acute apex in *G. reticulata*. Anthers are broadly oblong in *G. kunawarensis* or oblong in *G. reticulata*. Style is as long as ovary or longer.

Capsules are generally broadly obovoid and trilobed. In *G. anisanthos* capsules are deeply triquetrous and concave at the top. Seeds are of two types: globose and subcompressed, on the basis of which Pascher (1905) divided the genus into two subgenera.

Inflorescence often bears large number of small bulbils in the axils of bracts, instead of producing flowers or flowering branch. As such bulbil bearing inflorescence of *G. kunawarensis* is different from the flower bearing inflorescence when they are sometimes treated as 2 distinct species. In normal flowering, bulbels are produced inside the bulb. It appears that production of bulbels inside the bulb is inversely proportional to the production of bulbils in the inflorescence. There may be one bulbil at the axil as in *G. kunawarensis*. Bulbil often produces radical leaf while still attached to the inflorescence.

As such formation of capsule and seed setting is reduced in the genus and reproduction is chiefly carried on by vegetative means.

Chromosome number: Chromosomes of different species of *Gagea* growing in Indian subcontinent have been studied by various workers. Chromosome number of *G. lutea* (L.) Ker-Gawl. has been reported as $2n=72$ by Tischler (1934), Westerguad (1936), Malik (1961), Masicek & Hronka (1974), Vachova & Majovsky (1978), and Vachova (1980); as $2n=36$ by Leute (1974), $2n=96$ and 132

by Kaul & Gohil (1973). Chromosome number has been reported as $2n=24$ in *G. reticulata* (Pall) Schults f. by Malik & Sehgal (1959), Heyn & Dafni (1971), Kaul & Gohil (l.c.); as $2n=48$ in *G. persica* Boiss by Mehra & Sachdeva (1971) and $2n=72$ (in *G. stipitata* Merckl. = *G. persica*) by Kaul & Gohil (l.c.) and *G. persica* Boiss. var. *kashmiriensis* (Turriell) Dasgupta & Deb as $2n=24$ by Kaul & Gohil (l.c.). 48 and 60 chromosome numbers have been reported by Kaul & Gohil (l.c.) in *G. kunawarensis* (D. Don) Greuter (= *G. dshungarica* Regel, *G. gageoides* (Zucc.) Vved.).

This wide occurrence of polyploidy appears to be the reason for less fruit formation and less seed setting.

INFRAGENERIC CLASSIFICATION OF THE GENUS *Gagea*

Salisbury (1806) while postulating the genus was in favour of subdividing *Gagea* but did not do so. C. Koch (1849) divided the genus into 2 groups: *Holobulbos* and *Didymbulbos* without indicating the rank, on the basis of number of daughter bulbs present inside the bulb and origin of scape inside. W.D.J. Koch (1857) divided the genus into 3 sections, on bulb characters, without giving names. Two of these tally with the grouping of C. Koch and third one was later named by Boissier (1882) as sect. *Tribolbos*. Boissier (l.c.) divided the genus into 4 sections on the bulb and seed character. He validated the names of the sections given by C. Koch and W.D.J. Koch and erected a new section *Platyspermum* separating some species from *Holobulbos*.

Pascher (1904 & 1905) divided the genus *Gagea* into two subgenera *Eugagea* and *Hornungia* on the basis of seed character. He

subdivided the subgenus *Eugaea* into 4 sections following 3 of W.D.J. Koch and adding a new section *Monophyllos* distinguished from *Didymobulbos* (Pascher 1904). He also subdivided the subgenus *Hornungia* into section *Platyspermum* Boiss. (1882) and *Plerostigma* (Plectostigma Turcz. 1844), and further subdivided the sections into subsections etc. Pascher (l.c.) was followed by Krause (1930) in dividing the genus into subgenera and sections.

Terracciano (1905) followed Pascher (l.c.) in recognizing subgenera on seed character but named the subgenus *Hornungia* Pascher as *Gageastrum* Terracc. He divided the subgenera into sections, subsections and series of his own. Subgenus *Eugaea* Pascher was divided into two sections *Nudiscaposae* and *Foliatae* on number and arrangement of leaves and inflorescence characters. Subgenus *Gageastrum* Terracc. was divided into sections *Verticillatae* and *Anthericoides* on bulb and scape characters, the latter being placed under the genus *Lloydia*.

Grossheim (1935) in Flora U.S.S.R. followed Terracciano (l.c.) in dividing the subgenus *Eugaea* Pascher into sections, subsections, series etc. But named the other subgenus as *Platyspermum* (Boiss.) Misch. (1913) (syn. *Hornungia* Pascher, *Gageastrum* Terracc.) and divided this into sections, subsections, series etc. following Pascher (l.c.). Series, subseries, cycles etc. divisions proposed by Pascher, Terracciano and Grossheim were not validly published.

Gagea is a genus reproducing mostly by vegetative means such as bulbs, bulbels and bulbils, and scarcely producing seeds. As such in many cases identification on seed character is not feasible.

Moreover, it is observed that many species

so long kept in the subgenus *Platyspermum* (Boiss.) Misch. (*Hornungia* Pascher) are more allied to the subgenus *Eugaea* Pascher (= *Gagea*), leaving aside the type.

Gagea gageoides (Zucc.) Vved. kept in the subgenus *Platyspermum* is bulbiferous form of *G. dshungarica* Regel kept in the other subgenus *Eugaea*, the details of which along with nomenclatural aspect are discussed later.

12 species of *Gagea* distributed in the Indian subcontinent are grouped in two subgenera *Gagea* and *Hornungia* (Bernh.) Pascher.

KEY TO THE SUBGENERA SECTIONS AND SPECIES OF *Gagea*

- 1a. Flowers in loose panicle of corymb or scorpioid cyme or raceme or solitary. Bracts scattered on the inflorescence subgen. *Gagea*
- 2a. Inflorescence loose panicle of corymb or racemose. Cauline leaves if more than 1, alternate sect. *Gagea*
- 3a. Cauline leaves and bracts distinguishable. Stem naked below the inflorescence
- 4a. Ovary sessile
 - 5a. Radical leaf linear to lanceolate. Anthers rotund or broadly oblong....1. *G. kunawarensis*
 - 5b. Radical leaf linear. Anthers oblong 2. *G. improvisa*
- 4b. Ovary stipitate 3. *G. persica*
- 3b. Cauline leaves and bracts indistinguishable. Stem not naked below the inflorescence.
- 6a. Leaves without bulbiferous base. Perianth segments obtuse4. *G. olgae*
- 6b. Leaves with bulbiferous base. Perianth segments acute
 - 7a. Flowers 3-4, in raceme. Pedicel long 5. *G. bulbifera*
 - 7b. Flowers solitary, terminal. Pedicel short 6. *G. pamirica*
- 2b. Inflorescence scorpioid cyme. Cauline leaves 2, subopposite sect. *Holobulbos*
- 8a. Cauline leaves lanceolate or broadly lanceolate. Outer perianth glabrous in-

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side. Plants bigger (12-20 cm)
9a. Ovary and capsule not depressed above. Radical leaf 1

.... 7. *G. lutea*

9b. Ovary and capsule depressed above.
Radical leaves 2 ... 8. *G. anisanthos*

8b. Cauline leaves filiform. Outer perianth villous inside. Plants smaller (6-8 cm)

... 9. *G. toppinii*

1b. Flowers in umbel, rarely solitary. Bracts at the base of the inflorescence ... subgen. *Hornungia*

10a. Cauline leaves straight, linear-lanceolate, many

11a. Inflorescence terminal, longer (up to 6 cm long) ... 10. *G. reticulata*

11b. Inflorescence lateral, shorter (up to 2 cm long) ... 11. *G. setifolia*

10b. Cauline leaves curved, linear, few
... 12. *G. chitralensis*

Gagea Salisb. subgen. Gagea

Ornithoxanthum Link, Handb. 1: 161. 1829.
Bubillaria Zucc. in Pl. Hort. Bot. Moench 3: 229. t. 2. 1843 (Type: *B. gageoides* Zucc.).

Gagea Salisb. sect. *Platyspermum* Boiss. Fl. Or. 5: 203. 1882, pro parte, minore. *Gagea* Salisb. subgen. *Eugagea* Pascher in Lotos 24: 110.

1904; Terracc. in Soc. Bot. France Mem. 2. ser. 4, 5: 11. 1905; Krause in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 15a: 318. 1930;

Grossh. in Komarov, Fl. U.S.S.R. 4: 69. 1935. *Gagea* Salisb. Subgen. *Hornungia* (Bernh.) Pascher in Lotos 24: 115. 1904, pro *G. bulbifera* and pro subsect. *Stipitatae* Pascher. *Gagea*

Salisb. sect. *Nudiscaposae* Terracc. in Soc. Bot. France Mem. 2. ser. 4, 5: 11. 1905; Bull. L'Herb. Boiss. ser. 2, 5(11): 1062. 1905; Grossh. in Komarov, Fl. U.S.S.R. 4: 69. 1935.

Lectotype: *G. minima* (L.) Ker-Gawl.

Flowers in loose panicle of corymb or scorpioid cyme or raceme or rarely solitary and terminal. Bracts scattered in the inflorescence, single at the base of each of the ramification of the peduncle. *Cauline leaves* distinct and

bigger than the bracts or indistinct and gradually decrease in size upwards; generally at the base of the inflorescence, often all over the stem.

Distribution: Throughout the range of the genus.

Gagea Salisb. sect. Gagea

Gagea Salisb. sect. *Didymobolbos* Koch in Linnaea 22: 226. 1849, pro parte; Boiss. Fl. Or. 5: 203. 1882; Pascher in Lotos 24: 111.

1904; Krause in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 15a: 318. 1930. *Gagea* Salisb. sect. *Platyspermum* Boiss. Fl. Or. 5: 203. 1882,

pro *G. persica*; Pascher in Lotos 24: 118. 1904, pro subsect. *Stipitatae*. *Gagea* Salisb. sect. *Monophyllos* Pascher in Lotos 24: 113. 1904;

Krause in Engl. & Prantl, Nat. Pflanzenfam. ed. 2. 15a: 319. 1930. *Gagea* Salisb. sect. *Nudiscaposae* Terracc. pro parte — *Unispathaceae* Terrecc. in Bull. L'Herb. Boiss. Ser. 2,

5(11): 1062. 1905.

Lectotype: *Gagea minima* (L.) Ker-Gawl.

Inflorescence much branched, loose, panicle of corymb. *Cauline leaf* 1 or 2 when alternate, below the inflorescence. Bracts at the base of each of the ramification of the division of the peduncle. Often lower flowers are replaced by bulbils at the axils of the bract. *Seeds* subcompressed.

Distribution: Eurasia through Afghanistan, Pakistan to N.W. Himalayas from Kashmir to H.P.

1. *G. kunawarensis* (D. Don) Greuter in Israel Journ. Bot. 19: 155. 1970.

Basionym: *Lloydia kunawarensis* D. Don in Royle III. 388. t. 93. f. 3. 1840 (Type: Chango in Kunawar, Royle LIV!). *Bubillaria gageoides* Zucc. Pl. Hort. Bot. Moench 3: 230. t. 2. f. 1. 1843 (Type: Lebanon, 1838, Roth s.n. — Plate seen). *Gagea persica* Boiss.

Diagn. Ser. 1, 7: 108. 1846, pro parte (Type: Iran-Esfahan, *Aucher* 5404 BM — duplicate). *G. dshungarica* Regel in Act. Hort. Petrop. 6: 513. 1879 (Type: China-Dzungarian, 3-6000 ft, *A. Regel* LE); Pascher in Lotos 24: 113. 1904 & in Bull. Nat. Mosc. 4: 360. 1906; Grossh. in Komarov, Fl. U.S.S.R. 4: 75. 1935; Wendelb. in Koie & Rechinger, Symb. Afghan. 4: 159. 1958; Kachroo *et al.* Fl. Ladak. 157. 1977, *syn. nov.* *G. gageoides* (Zucc.) Vved. Fl. Turkm. 1(2): 261. 1932; Grossh. in Komarov, Fl. U.S.S.R. 4: 110. 1935; Wendelb. in Koie & Rechinger, Symb. Afghan. 4: 159. 1958, *syn. nov.* (Fig. 2).

Herbs 6-10 cm long; bulbs 0.6-1.5 x 0.4-1 cm, profusely rooting below; outer scales fibrous, dull brown; bulbels present or absent. *Radical leaf* 1, 6-10 x 0.4-0.8 cm, linear to lanceolate. Stem 4-6 cm, more or less as long as the leaf, terete, flexuous, naked below the inflorescence. *Cauline leaf* 1, below the inflorescence, 2-5 x 0.4-0.7 cm, linear, lanceolate or broadly lanceolate. *Inflorescence* panicle of corymb with many flowers or with many axillary bulbils and few flowers, each at the tip of a branch. *Flowers* golden yellow inside, pale green outside, campanulate, 5-6 mm long; pedicel 0.5-1 cm long, filiform; bracts many, 2-20 x 1-5 mm, linear-lanceolate, each enclosing a cluster of (10) bulbils except the top one. *Perianth* segments 4-6 x 1.5-2 mm, oblanceolate or elliptic, obtuse; veins 3-7. *Stamens* about as long as the perianth; filaments 3-5 x 0.5 mm, linear; anthers 0.7-1 x 0.7 mm, rotund or broadly oblong. *Ovary* sessile, 1.5-3 x 1-2 mm, obovoid, trilobed; style 2-2.5 mm; stigma 0.5 mm broad, truncate. Capsule obconical.

Flowering: April-August.

Fruiting: June-August.

Ecology: Dry slopes, open fields, gravelly

places in foothills and in the middle mountain zone, on edges of snow line, at an altitude of 1700-3700 m. Bulbils are developed in the drier desert regions.

Distribution: W. Asia, C. Asia, Afghanistan and Pakistan to N. W. Himalayas in India. (Fig. 1).

Note: On study of the protologues, plates, and specimens identified by Wendelbo, Stewart, and Bornmuller, no significant distinction could be established amongst *Lloydia kunawarensis* D. Don, *G. gageoides* (Zucc.) Vved. and *G. dshungarica* Regel, except the presence of numerous axillary bulbils in *G. gageoides*. *G. dshungarica* and *L. kunawarensis* with many flowered panicle of corymb without floral bulbils are conspecific.

Specimens collected by *T. Thomson* from N.W. Himalayas extant in CAL, BM, L, show both types — bulbils bearing *G. gageoides* and without bulbils *G. dshungarica* in the same gathering. Both of these represent the same species, and one is the bulbuliferous form of the other.

It is further observed that the branching of the inflorescence is often inhibited and flower production is reduced when numerous bulbils are produced. It is also observed that when axillary bulbils are developed in the inflorescence the underground bulbs do not develop bulbils inside, whereas many bulbels are present in the mother bulb when inflorescence is devoid of bulbil. Presence of bulbel inside the bulb is directly correlated with the absence of axillary bulbils. *Aucher* 5404 — Syntype of *G. persica* seen in BM is bulbuliferous — *G. kunawarensis*.

Herbarium specimens examined: INDIA: Kashmir, Baramula, *G. Watt* s.n. (BSIS); Kungwalan, *T. A. Rao* 9296 (BSD) & *G. Saran & party* s.n. (LWG); Liddar valley,

Inayat 25765 (K); N.E. of Murgan Pass, *G. L. de La G. Fuller* 15 (K); Tanmarg, *P. Timins* 22 (BM); Pir Panjal, *J. E. Winterbottom* 109 (CAL); Balti, *J. E. Winterbottom* (CAL), *T. Thomson* s.n. (CAL, BM, L).

PAKISTAN: Darkot, *S. Bowes Lyon* 8085 (K); Chitral, *J. O. A. Stainton* 2338 (BM) & *S. A. Bowes Lyon* 623 (BM); Kagan valley, *Inayat* 20214 & 20215 (CAL).

IRAN: Kerman, *J. Bornmuller* 4740 (G); *G. Shahrud* — Bustan (Turam protected area) *K. H. Rechinger* 50431 (G); Monte Elwend, *Th. Pichler* (G, CAL).

2. *G. improvisa* Grossh. in Komarov, Fl. U.S.S.R. 4: 737. 2. 44. f. 1. a-c. 1935 (Type: Turkey- Ordubad, April, 1933, *T. Heideman* & *Prilipko* s.n. BAK). (Fig. 2).

Herbs 14-25 cm long; bulbs 2-2.5 x 0.8-1.5 cm; outer scales brown or brownish black, coriaceous; bulbels numerous inside the outer scales; sheath 0.5-0.7 cm long. *Radical leaves* 1, 14-22 x 0.4-0.5 cm, as long as the plant or longer, linear. Stem 10-15 cm long, glabrous, naked below. *Cauline leaves* alternate, distant, pass to bract, lower 3-5 x 0.4-0.5 cm, linear-lanceolate. *Inflorescence* panicle of corymb of 2-10 flowers. *Flowers* yellow, greenish outside, 8-12 mm long; pedicels 1-2 cm long; bracts 0.5-1 cm long, linear-lanceolate. *Perianth* segments 8-12 x 3-4.5 mm, elliptic, obtuse, 7 open veined. *Filaments* 4-5.5 x 1 mm, linear; anthers \pm 2 x 1 mm, oblong. *Ovary* sessile, 4-4.5 x 1.5-2 mm, oblong; style 4-4.5 mm long; stigma 1 mm broad, trilobed.

Flowering: June.

Distribution: Turkey to Afghanistan and Pakistan at 3830 m in altitude. (Fig. 1).

Herbarium specimens examined: PAKISTAN: Chitral, *S. W. Bowes Lyon* 887 (BM). AFGHANISTAN: Badghis, *J. E. T. Aitchison* 1131 (CAL).

3. *G. persica* Boiss. Diagn. Pl. Or. Nov. 1(7): 108. 1846, pro parte (Type: Iran — Persepolis, *Kotschy* 237 — BM! CAL! G! K — photo!); Boiss. Fl. Or. 5: 210. 1882; Collett, Fl. Simlens. 599. 1902; Pascher in Lotos 24: 118. 1904; Bamber, Pl. Punj. 499. 1916. *G. stipitata* Merckl. ex Bunge in Mem. Acad. Petersb. 7: 512. 1851 (Type: Crimen-Bakali, *Lehmann* 1385 S) & in Ic. Regel Izv. Obshch. Lyubit. Estest. Antr. 1. Ethnogr. 21(2): 116. t. 19. 5-8, 1876; Regel in Act. Hort. Petrop. 3: 291. 1875; Grossh. in Komarov, Fl. U.S.S.R. 4: 109. 1935; Wendelb. in Koie & Rechinger, Symb. Afghan. 4: 160. 1958. *G. afghanica* Terracc. in Bull. Soc. Ort. Palermo 2: 4. 1904 (Type: Turkmenistan-Krasnovodsk, *P. sintensis* 6 (G); Turkestan, Ajak, *Korolkow* LE; Afghanistan, Harirud valley, *Aitchinson* 1130 K); Pascher in Bull. Nat. Mosc. 14: 372. 1906; Grossh. in Komarov, Fl. U.S.S.R. 4: 107. 1935; Wendelb. in Koie & Rechinger, Symb. Afghan. 4: 158. 1958, *syn. nov.*

Herbs 14-23 cm long; bulbs 0.6-1 x 0.4-0.8 cm, profusely rooting below; outer scales dull brown, fibrous, bulbels inside. *Radical leaf* 1 or 2, 10-19 cm x 1 mm, linear; as long as inflorescence. Stem 11-23 cm long, terete, glabrous or hairy, naked. *Cauline leaves* 2, alternate, 1-5 x 0.2-0.4 cm, lanceolate or linear-lanceolate, glabrous or pilose. *Inflorescence* 3-14 cm long, loose panicle of corymb 3-10 flowers. *Flowers* yellow or white within, greenish or pinkish outside; pedicel 1-3.5 cm long, filiform; bracts 1-10 x 1-2 mm, linear, often hairy; sometimes flowers are replaced by bulbils. *Perianth* segments 4-11 x 1.5-3 mm, lanceolate, glabrous, acute, membraneous at the margin; veins 5-7, open, midvein prominent. *Stamens* nearly as long as perianth; filaments 3-5 x 0.5 mm, linear; anthers 1-2 x 0.7-1.5 mm, broadly oblong, or rotund, dorsifixed,

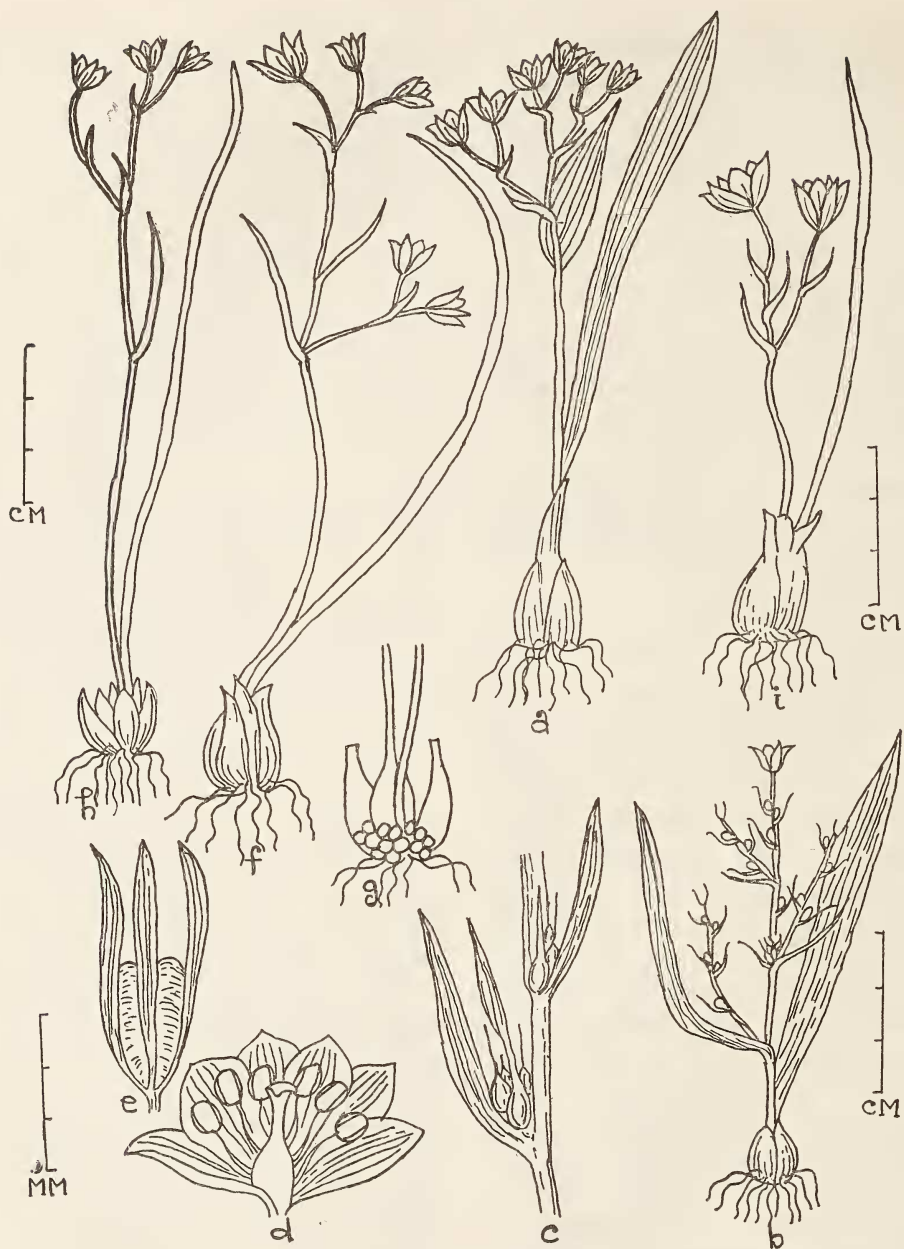


Fig. 2. *Gagea kunawarensis* (D. Don) Greuter — a) whole plant with flowers; b) whole plant with axillary bulbils; c) bulbils; d) flower showing different parts; e) capsule with persistent perianth. *G. improvisa* Grossh. f) whole plant; g) bulb scales removed, showing base of radical leaf and stem, outer scale and bulbels. *G. persica* Boiss — h) whole plant, *G. olgae* Regel — i) whole plant.

TAXONOMIC REVISION OF THE GENUS GAGEA

latrorse. Ovary stipitate, 2-3 x 1.5-2 mm, obovoid or obovoid-oblong, trilobed; style 2-3 mm long, linear; stigma trilobed. Capsules 5-6 mm long, obovoid, stipitate. Seeds many, subcompressed.

Note: Description and plate of *G. stipitata* Mercklin ex Bunge in Ic. Regel tally perfectly with the *Kotschy 237*.

Other syntype of *G. persica*, *Aucher Eley 5404* is a different plant. *G. afghanica* was proposed by Terracciano as distinct from *G. stipitata* for perianth purple outside. But this is not tenable. As such, *G. stipitata* and *G. afghanica* are reduced to synonyms of *G. persica* Boiss.

KEY TO THE VARIETIES OF *G. persica*

- 1a. Stem glabrous. Radical leaf 1
 ... a. var. *persica*
 1b. Stem pilose. Radical leaves 2
 ... b. var. *kashmiriensis*
 a. var. *persica* (Fig. 2).

Bulbels many inside the outer scales of the bulb. *Radical leaf* 1, linear. *Stem* glabrous. *Cauline leaves* 2, alternate, glabrous, lower bigger. *Flowers* yellow or white within and greenish or pinkish outside, 5-8 mm long. *Capsules* obovoid, stipitate. *Seeds* many, subcompressed.

Flowering: April-July.

Fruiting: Not seen.

Ecology: Damp plains sometimes on metamorphic rocks at an altitude of 1524-3960 m.

Distribution: S. Russia, W. Asia to India in Kashmir and H. P. (Fig. 1).

Note: Capsule and seed characters were taken from Grossh. (l.c.).

Herbarium specimens examined: INDIA: Kashmir, *T. Thomson 29* (CAL, L, BM), *Jaeschke* s.n. (CAL), *A. Meebold 4115* (CAL), *B. O. Coventry 1319* (K) & *P. N. Kohli 36* (K). Himachal Pradesh, Spiti, *Stolickza* s.n. (CAL); Lahul, *Stolickza* s.n. (CAL), *Bhatta-*

charya 48602 (BSD), *Capt. Hay* (CAL) & *Walter Koeltz* (K). PAKISTAN: Murdar, *J. H. Lace 3533* except one specimen (*G. setifolia*) (CAL); Quetta, *J. F. Duthie 8725, 8726* (CAL), and *8727* (CAL, K); Chitral, *S. A. Bowes Lyon 624* (BM). Iran: Persepolis, *Kotschy 237* (CAL, G); Kernan-Kuhi, *J. Bornmuller 4746* (G). Turkmenia: Askhabad, *P. sintensis 43* (G).

b. *G. Persica* Boiss. var. *kashmiriensis* (Turrill) Dasgupta et Deb comb. et stat. nov.

Basionym: *Gagea kashmiriensis* Turrill in Kew Bull. 1928: 77. 1928 (Type: Kashmir, Srinagar, 5700 ft. *Canon stokoe 2* holotype K — Photo!).

Daughter bulb 1, inside the outer scales of the bulb. *Radical leaves* 2, linear. *Stem* hairy. *Cauline leaves* 2, alternate, pilose, lanceolate. *Flowers* yellow, 7-11 mm long. *Capsules* not seen.

Flowering: March-July.

Altitude: 1524 m.

Distribution: Kashmir (Fig. 1).

Herbarium specimens examined: INDIA: Kashmir, *Rev. Jaeschke* s.n. (CAL), *Meebold 4115* (CAL), *T. Thomson 29* (CAL, L), and *B. O. Coventry 1445* (L).

4. *G. olgae* Regel in Act. Hort. Petrop. 3: 292. 1875 (Type: Uzbekistan — Samarkand, *O. Fedchenko* LE; Turkestan — *Korolkow & Krause* LE); Mercklin ex Bunge in Ic. Regel Izv. Obsheh. Lyubit. Estest. Antr. i. Etnogr. 21(2): 116. t. 18. f. 13-17. 1876; Pascher in Lotos 24: 117. 1904 & in Bull. Nat. Mosc. 4: 327. 1905; Grossh. in Komarov, Fl. U.S.S.R. 4: 106. 1935; Wendelb. in Koie & Reching. Symb. Afghan. 4: 159. 1958. *G. jaeshkei* Pascher in Lotos 24: 128. 1904 (Type: India — Himachal Pradesh, Keylang LE) & Bull. Nat. Mosc. 4: 371. 1905, *syn. nov.* (Fig. 2).

Plants 5-15 cm long; bulbs 1-2 x 0.5-1.5

cm, ovoid with a collar above and profuse roots below; outer scales fibrous; collar up to 3 cm long. *Radical leaf* 1, longer than stem, 6-18 x 0.1-0.25 cm, linear, glabrous. *Stem* 5-15 cm long, terete, glabrous or puberulous, leafy above. *Cauline leaves* alternate, linear; gradually diminishing in size upwards, not distinct from the bracts. *Inflorescence* terminal, 1-3-flowered, raceme. *Flowers* 8-18 mm long, campanulate, bright yellow, often brownish outside; pedicel 0.3-2.5 cm; bracts leafy. *Perianth* segments 8-18 x 2.5-3 mm, lanceolate or oblong, obtuse, scarious at margin; veins 3-7 diverging. *Filaments* \pm 4 x 0.5 mm, linear; anthers \pm 2 x 0.7 mm, linear — oblong. *Ovary* sessile, 3 x 1.5 mm, oblong; style 4 x 0.5 mm, linear; stigma trilobed. *Capsules* 6-8 mm long, obovoid.

Flowering: May-June.

Ecology: Stony hillsides, at an altitude of 3500-4200 m.

Distribution: C. Asia to Pakistan and India in W. Himalayas (Fig. 1).

Herbarium specimens examined: Pakistan: Chitral, *Bowes Lyon* 876, 733 & 1006 (BM); *J.D.A. Stainton* 2495 (BM);

5. *G. bulbifera* (Pall.) Salisb. in Konig & Sims. Ann. Bot. 2: 557. 1806; Schultes f. in Roem. et Schultes, Syst. Veg. 7: 552. 1829; Ledeb. Ic. Pl. Fl. Ross. 4: 142. 1829; Kunth, Enum. Pl. 4: 243. 1843; Boiss. Fl. Or. 5: 210. 1882; Pascher in Lotos 24: 115. 1904 & in Bull. Nat. Mosc. 4: 369. 1906; Miscz., Fl. Cauc. Grit. Ser. 3, 4: 174. 1913; Grossh. in Komarov, Fl. U.S.S.R. 4: 108. 1935.

Ornithogalum bulbiferum Pall. Reise 2(2): 736. t. Q. f. 2. 1776 (Type: U.S.S.R. — Astrakhan, *Pallas* LE; CAL — isotype! Linn. Suppl. 199. 1781; Reichenb. Icon. Fl. Germ. t. 117. 1846.

Plants small; bulbs 5-16 x 4-8 mm, outer

brownish, fibrous, profusely rooting. *Radical leaf* single, 3-16 x 0.15 cm, linear. *Stem* 5-18 cm long, slender, glabrous. *Cauline leaves* 3-4, alternate, 1.5-6 cm, linear, shorter than inflorescence, gradually diminishing in size up the stem, bulging at base with a small bulbil inside the swelling. *Inflorescence* 3-4-flowered raceme. *Flowers* campanulate; pedicel 2-4 cm long, slender, nodding; bracts leafy. *Perianth* segments-outer green, inner greenish, 8-13 x 7.5-2 mm, lanceolate, scarious at margin, acute at apex, veins 7, diverging, midvein distinct. *Stamens* half as long as the perianth; filaments 5-7 mm, linear; anthers 1.25-2 x 0.75 mm, oblong. *Ovary* sessile, 3-4 x 1 mm, oblong, style 3.5-4.5 mm, linear; stigma trisulcate. *Capsules* ovoid, rounded, trigonous, half as long as the perianth.

Flowering: March-May.

Fruiting: Not seen.

Ecology: Gravelly slopes at an altitude of 1670 m.

Distribution: South U.S.S.R., C. Asia to India in Himachal Pradesh (Fig. 1).

Herbarium specimens examined: INDIA: Himachal Pradesh, Simla, *K. R. Johnson* (CAL) & *J. R. Drummond* 20926 (K); U.S.S.R.: Astrakhan, *Pallas* s.n. (CAL). C. Asia: Altai, *Gobler* s.n. (CAL).

Note: Description of fruit taken from Grossh. in Komarov, Fl. U.S.S.R. 4: 108. 1935.

6. *G. pamirica* Grossh. in Komarov, Fl. U.S.S.R. 4: 108 & 738. 1935 (Type: U.S.S.R. Fergana Pamir, Northern Slope, 12000 ft, 1.7.1901, *Alexeenko* s.n. LE); Wendelb. in Koie & Reiching. Symb. Afghan. 4: 160. 1958. (Fig. 4).

Plants 4-9 cm long; bulb 1-2 x 0.7-1 cm, profusely rooting below, bulb-scales fibrous. *Radical leaves* 2, 4-10 x 0.15-0.2 cm, linear. *Cauline leaves* many (15-16), 1-4 x 0.1 cm,

gradually diminishing in size upwards, sparse below and closed above, ciliate at margin; bulbils at the axil of leaves, 1-1.5 x 1 mm. *Flowers* solitary, terminal, 11-15 mm long, campanulate; pedicel \pm 2 mm long; bracts indistinct. *Perianth* segments 11-15 x 2.5-4 mm, broadly oblong, acute, 5-7-veined, scarious at margin. *Filaments* 2.5-6 mm, linear, attached at the base of the perianth; anthers 2-2.5 x 0.7 mm, linear-oblong. *Ovary* 4-6 x 1-1.5 mm, oblong, triquetrous; style 3-4 mm long, broader above, trigonous; stigma 1 mm broad, trilobed.

Flowering: June-July.

Ecology: Grassy and gravelly alpine zone at altitudes of 3695-3810 m.

Distribution: C. Asia in Pamir extending to Pakistan in Chitral (Fig. 1).

Herbarium specimens examined: Pakistan: Chitral, Bowes Lyon 878 (BM).

Gagea Salisb. sect. **Holobulbos** C. Koch in *Linnaea* 22: 226. 1849, pro parte — major; Boiss. *Fl. Or.* 5: 203. 1882; Pascher in *Lotos* 24: 113. 1904; Krause in *Engl. & Prantl, Nat. Pflanzenfam.* ed. 2. 15a: 318. 1930. *Gagea* Salisb. sect. *Didymbulbos* C. Koch. in *Linnaea* 22: 226. 1849, pro parte — major; Boiss. *Fl. Or.* 5: 203. 1882; Pascher in *Lotos* 24: 111. 1904; Krause in *Engl. & Prantl, Nat. Pflanzenfam.* ed. 2. 15a: 318. 1930. *Gagea* Salisb. sect. *Tribolbos* W.D.J. Koch, *Syn. Fl. Germ.* 2: 619. 1857; Boiss. *Fl. Or.* 5: 203. 1888. *Gagea* Salisb. sect. *Nudiscaposae* Terracc. in *Soc. Bot. France Mem.* 2. ser. 4, 5: 12. 1905, pro subsect. *Dispathaceae*.

Lectotype: *G. lutea* (L.) Ker-Gawl.

Inflorescence condensed scorpioid cyme
Cauline leaves 2, subopposite, distinct from leaves, lower bigger, as long as the inflorescence. Pedicel long. Daughter bulb present or not. *Seeds* not compressed.

Distribution: From Afghanistan, Pakistan to Himalayas in the states of Kashmir, H.P., U.P. to Nepal, Sikkim.

7. **G. lutea** (L.) Ker-Gawl. in *Curtis' Bot. Mag.* 30: t. 1200. 1809; Schultes f. in *Roem. & Schultes, Syst. Veg.* 7: 538. 1829; Kunth, *Enum. Pl.* 4: 235. 1843; Boiss. *Fl. Or.* 5: 207. 1882; Hook. f. *Fl. Brit. Ind.* 6: 355. 1892; Collett, *Fl. Simlens.* 529. 1902; Pascher in *Lotos* 24: 114. 1904; Terracc. in *Bull. L'Herb. Boiss. ser. 2, 5(11)*: 1070. 1905; Bamber, *Pl. Punj.* 498. 1916; Blatter, *Beaut. Fl. Kashmir* 2: 170. 1928; Grossh. in *Komarov, Fl. U.S.S.R.* 4: 78. 1935. *Ornithogalum luteum* L. *Sp. Pl.* 306. 1753 (Type: Upsala, *Linn.* 428.4 LINN). *G. fascicularis* Salisb. in *Kon. & Sims. Ann.* 2: 555. 1806 (Type: Greta Bridge, *H. Johnson s.n.*; Tubingen, *Fuchs s.n.*; Woodstock — *J. Banks s.n.* K, BM — duplicate of the Paratype!). *G. elegans* Wall. ex D. Don in *Royle, Illustr. Bot. Himal.* 388. t. 95. f. 1. 1840 (Type: Kumaon, Wall. Cat. 5065, K-W Photo! BM!); Pascher in *Lotos* 24: 114. 1904; Terracc. in *Bull. L'Herb. Boiss. ser. 2, 5(11)*: 1068. 1905; Pascher in *Bull. Nat. Mosc.* 14: 364. 1906. *G. indica* Pascher in *Fedde Repert.* 2: 111. 1906 (Type: India Boreales — Himalaya LE) & in *Bull. Nat. Mosc.* 19: 364. 1906, *syn. nov.* *G. lowariensis* Pascher in *Fedde Repert.* 2: 111. 1906 (Type: Chitral, Lowari Pass, *Harriss* 16699, pro parte K Photo! CAL — duplicate of the type!) & in *Bull. Nat. Mosc.* 4: 364. 1906; Wendelb. in *Koie & Reching. Symb. Afghan.* 4: 159. 1958, *syn. nov.* *G. moorcroftiana* Wall. Cat. 5063, nom. nud. *G. pulchella* Wall. Cat. 5064, nom. nud. (Fig. 3).

Herbs small, gregarious; bulbs deep brown, 1-3 x 0.5-2 cm, ovoid or subglobose, profusely rooting below; outer scales black in colour, bulbels many, inside. *Radical leaf* solitary, 6-35 x 0.2-2 cm, linear-lanceolate to broadly lan-

ceolate, acute, glossy, overtopping the inflorescence. *Stem* 5-22 cm, terete, naked. *Cauline leaves* 2, enclosing the inflorescence, subopposite, 3-8 x 0.3-1 cm, lanceolate or broadly lanceolate, lanate inside. *Inflorescence* compressed scorpioid cyme, up to 7-flowered, 0.5-2 cm long, lowest overtop the whole inflorescence. Flowers ascending, 9-14 mm long, broadly campanulate; pedicel 1.5-6 cm, linear often lanate; bracts 1.5-3.0 x 0.3-0.5 cm, one at each node, linear. *Perianth* segments persistent, bright yellow within, externally green with yellow margin, 9-14 x 2-3.5 mm, lanceolate or broadly lanceolate, obtuse, glabrous, scarious at margin; veins 7, open, midvein prominent. *Filaments* yellow, subulate; 3-8 mm long, unequal, anthers orange, varying in size, 1-2.5 x 0.5-1 mm, linear-oblong or oblong, latrorse. *Ovary* green, sessile, 2-4 x 1.5-2 mm, obovoid or obovoid-oblong, not depressed above; style pale green, 4-7 mm long, linear trisulcate; stigma truncate, trilobed, obscurely papillose. *Capsules* 4-6 x 5-6 mm, broadly obovoid, trilocular. *Seeds* 4 per locule, 2-3 x 1-1.5 mm, hemispherical or semi-rotund, wingless.

Flowering & fruiting: April to July.

Ecology: Open grassy hillside or humus rich plateau, in alpine forest at 2744-4270 m in altitude.

Distribution: Pakistan to India, along Himalayas in Kashmir, H.P., U.P. to Nepal and Sikkim. (Fig. 1).

Note: Originally *G. indica* Pascher was distinguished for the linear, hooded radical leaf, the ovate cauline leaf and the few-flowered inflorescence. *G. lowariensis* Pascher was distinguished for the broadly lanceolate (18-25 mm broad) radical leaf, the broadly elliptic cauline leaf and many-flowered inflorescence. Elliptic cauline leaves, many-flowered inflores-

cence and oblong or obovoid-oblong, acute perianth are the distinguishing characters of *Gagea lutea* (L.) Ker-Gawl. After examination of specimens it is observed that leaves are hooded in young stage but become spreading on maturity. Linear radical leaves, lanceolate cauline leaves associated with many flowers are seen in *Parker* 367, *Mackinnon* s.n., linear radical leaves, lanceolate cauline leaves associated with few flowers in *Strachey & Winterbottom* 62. Radical leaves of various breadth intermediate between *G. lutea* and *G. lowariensis* are seen in *T. A. Rao* 9308 and duplicate of the holotype of *Harriss* 16699. In view of the intergrading characters the distinction of these three species is not tenable and are conspecific.

PARTICULARS OF SOME SPECIMENS ARE GIVEN BELOW

| Specimens | Radical leaves | Cauline leaves | Flowers |
|---|---|---|---------|
| Kashmir, <i>Parker</i> 367 (CAL) | 23-30 x 0.6-0.8 cm linear | 8-9 x 1.2-1.5 cm lanceolate | 7 |
| N.W. Hima- laya <i>Mackinnon</i> s.n. (CAL) | 26-35 x \pm 1 cm linear | \pm 9 x 1 cm lanceolate | 6 |
| Kumaon, <i>Strachey &</i> <i>Winterbottom</i> 62 (CAL) | \pm 18 x 0.5 cm linear | \pm 3 x 0.5 cm lanceolate | 2-3 |
| Kashmir, <i>T. A. Rao</i> 9308 (CAL) | 12-15 x 1-1.2 cm linear- lanceolate | \pm 4 x 1 cm broadly lanceolate | 3-4 |
| Chitral, <i>Harriss</i> 16699 (CAL) | 18-19 x 1.5-1.7 cm lanceolate | \pm 7.5 x 1.5 cm broadly lanceolate | 6 |

Herbarium specimens examined: INDIA: Uttar Pradesh, Kumaon, *R. Blinksworth* s.n. in Wall. Cat. 5065 (CAL), *Strachey & Winterbottom* 62 (CAL, BM); *Awasthi* s.n. (LWG),

and Balapmet & Pandey 93361 (LWG); Tehri-garhwal, *M. A. Rau* 51651 (BSD), *N. C. Nair* 36787 (BSD), *Y. K. Sarin & M. A. Rau* 2918 (BSD), *W. Gattan* s.n. (CAL); *Duthie* 1278 (CAL) and *Haines* 2186 (K). Kashmir, Pirpanjal, *Winterbottom* 92 (CAL); Chenab, *Baden Powell* 311 (CAL), *R. Ellis* 1033 (CAL), Mulluk & South of Bhabeh Pass, *Stolizka* s.n. (CAL); Kajnag range, *Duthie* 11002 (CAL); Gulmarg, *A.K.K.* 9 (CAL), *Thaplyal & Raizada* 26447 (L); *Khilenmarg, Singh* 277 (L), *Jajpal, M. A. Enershed* s.n. (BM); Gilgit, *G. M. Giles* 128 (CAL), Kinimonala, *Inayat* s.n. (K); Kungwalan, *T. A. Rao* 9308 (CAL, BSD), Himachal Pradesh, Lahul, *Brandis* s.n. (CAL) & *M. A. Rau* 5865 (BSD); Chamba, *R. Ellis* s.n. (CAL), *J. H. Lace* 1319 (BSIS) and *N. C. Nair* 32444 (BSD); Narkanda, *M. A. Rau* 11448 (BSD); Rohtang, *Stolizka* s.n. (CAL); Lectee, *Vicary* s.n. (CAL); Simla hills, *I. H. Burkill* 28661 (BSIS); Kunwar, *Drunmond* 26542 (K); N. W. Himalayas, *T. Thomson* 39 (CAL), *A. B. Royle* s.n. (CAL); *Mackinon* s.n. (CAL). Sikkim: Thangu, *K. Biswas* 6993 (CAL); Lachen, *L. L. Ternner* s.n. (BSIS); Soonderdunga glacier, *T. Anderson* s.n. (CAL). Nepal: Padmara Lagna, *Polunin, Sykes & Williams* 4065 (CAL); Dozamkhola, *Polunin, Sykes & Williams* 4233 (BM, CAL); Balangra Pass, *Polunin, Sykes & Williams* 1013 (BM); Near Dogadikhola, *Stainton, Sykes & Williams* 3179 (CAL); Tara Kot, *J. F. Dobremej* 162 (BM); Opikhola, *J. B. Tyson* 19 (BM); Saurekhola, *A. R. Vickary* 810 (BM). Pakistan: Chitral, *Stainton* 2331 & 2759 (BM), *Surg. Lt. Harriss* 16697, 16698 & 16699 (CAL, BM, K); Hazara, *Kagan, Inayat* 20211, 20212, 20213 & 22620 (CAL), *Duthie* 22620 (K), *Stewart* 222 (CAL); Jaunsar, *Gamble* 23125, 25935 (K); *A. Webb* (BSIS), *W. Gattan* 2089 (CAL, BM); Doab,

Wall. Cat. 3065 (BM).

8. *G. anisanthos* C. Koch in *Linnaea* 22: 230. 1849 (Type: S. Russia — *Lelwar, Koch* ER); *Ledeb. Fl. Ross.* 4: 140. 1852; *Terracc. Bull. L'Herb. Boiss. Ser. 2, 5(12):* 1119. 1905; *Misz. Fl. Cauc. Crit. Ser. 2, 4: 156.* 1912; *Grossh. in Komarov, Fl. U.S.S.R.* 4: 87. 1935. *G. liottardi* Boiss. *Fl. Or.* 5: 204. 1882. *G. fistulosa* *Misz. in Fl. Cauc. Crit. Ser. 2, 4: 154.* 1912. (Fig. 3).

Herbs 12-20 cm; bulbs brown, 6-8 x 5-6 mm; bulbel 1 or 2. *Stem* 7-15 x 0.2 cm, glabrous. *Radical leaves* 2, 15-20 x 0.2-0.3 cm, exceeding the inflorescence, linear, glabrous. *Cauline leaves* 2, subopposite, enclosing the inflorescence, lower longer than the upper, 4-8 x 0.3-0.6 cm, lanceolate, broader at the base, sheathing, plicate, glabrous. *Inflorescence* 2-8-flowered, condensed scorpioid cyme. *Flowers* 15-20 mm long, campanulate; pedicel diverging, 3-9 cm long, villous; bracts 1.5-4 x 0.2-0.3 cm, linear, glabrous. *Perianth* segments yellow, 1.5-2.0 x 0.4 cm, elliptic-lanceolate, subacute; margin revolute; veins 7, diverging. *Stamens* shorter than pistil and half the length of perianth; filaments 5-9 x 0.5-1 mm, linear; anthers \pm 2 x 0.7-1 mm, oblong. *Ovary* sessile, 5-8 x 3-4 mm, obovoid-triquetrous, depressed above; style short, 3-4 mm, stout; stigma 1-1.5 mm broad. *Capsules* 8.5-9.5 mm, obovoid, triquetrous, depressed above. *Seeds* 2 x 1.25 mm, ovoid, neither compressed nor angular, deep brown, wingless.

Flowering: April-May.

Fruiting: May.

Distribution: W. Asia, S. Russia to Kashmir at 2438 m in altitude (Fig. 1).

Herbarium specimens examined: INDIA: Kashmir, Baspasi Pass, *J. E. Winterbottom* 222 (CAL); Sonemarg, *W. F. Saxton* 1662 (CAL); Gulmarg, *B. O. Coventry* 1466 (K);



Fig. 3. *Gagea lutea* (L.) Ker-Gawl — a) whole plant; b) bulbs; c) flower showing different parts; d) capsule with persistent perianth; e & f) seed. *G. anisanthos* C. Koch — g) whole plant; h) capsule. *G. toppinii* sp. nov. — i) whole plant; j) dissected bulb showing radical leaf base, stem base and a bulbel.

Chandanweri, P. R. *Dahadghao* 0368 (CAL).
Jordon — Lyon s.n. (CAL).

9. **G. toppinii** sp. nov. Differt ab. *G. lutea* (L.) Ker-Gawl. foliis caulinis linearibus, foliis radicalibus bulbiferibusque ubi affixis in plantis maturis, perianthiisque exteriore villosis; ab. *G. anisanthos* C. Koch statura multo minore, perianthiis exteriore villosis, ovariis supra non depressis. Typus: Pakistan, Chitral, Major S. N. Toppin 17 (holotypus K) (Fig. 3).

Herbs 6-8 cm long; bulb 4-5 x 3-4 mm, ovoid; bulbel 1 or 2 often bearing leaves when still attached to the mother plant. *Radical leaves* 10-11 x 0.01 cm, linear, acute at the apex, glabrous, overtopping the inflorescence. *Stem* 1.5-2 cm terete, pubescent. *Cauline leaves* subopposite, at the base of the inflorescence, 1.5-5 cm long, filiform, about 1 mm broad at the base, the lower over-topping the inflorescence. *Inflorescence* 2-4-flowered condensed scorpioid cyme. *Flowers* broadly campanulate; pedicel 3-6 cm long, filiform, pubescent; bracts 3-5 mm long, filiform. *Perianth segments* 7-8 x 1.7-2 mm, lanceolate, acute at the apex, midvein prominent; dorsal side of outer segments pubescent. *Filaments* \pm 4 x 0.5 mm, linear; anthers \pm 1.2 x 1 mm, oblong. *Ovary* sessile, 3-3.5 x 1, oblong, triquetrous; style 3-3.5 x 0.5, linear, triquetrous; stigma trifold. *Fruit* not seen.

Distribution: Pakistan, Chitral (Fig 1).

Gagea Salisb. subgen. **Hornungia** (Bernh.) Pascher in *Lotos* 24: 115. 1904, pro subsect. *Reticulatae*-pro parte; Krause in *Engl. & Prantl. Nat. Pflanzenfam.* ed. 2. 15a: 318. 1930. *Hornungia* Bernh. in *Flora* 23: 392. 1840 (Type: *H. circinata* Bernh.). *Gagea* Salisb. sect. *Platyspermum* Boiss. *Fl. Or.* 5: 203. 1882 (Type: *Gagea reticulata* (Pall.) Schultes f.). *Gagea* Salisb. subgen. *Gageastrum* Terracc. in *Soc. Bot. France Mem.* 2. ser 4, t. 5. 21. 1903,

pro sect. *Verticillatae* Terracc. (Type: *Gagea reticulata* (Pall.) Schultes f.). *Gagea* Salisb. subgen. *Platyspermum* (Sciss.) Misch. *Fl. Cauc. Crit. ser.* 2, 4: 169. 1913; Grossh. in Komarov, *Fl. U.S.S.R.* 4: 94. 1935.

Type: *Gagea reticulata* (Pall.) Schultes f. *Inflorescence* umbel, rarely solitary, apical. Bracts arising from a single node at the base of the umbel. *Cauline leaves* not distinct from the bracts. *Scape* naked from the bulb to the inflorescence. *Perianth* acuminate. *Ovary* oblong, sessile. *Seeds* compressed.

Distribution: Russia, C. Asian desert to Afghanistan, Pakistan and India in W. Himalaya.

10. **G. reticulata** (Pall.) Schultes f. *Syst. Veg.* 7: 542. 1829; Kunth, *Enum. Pl.* 4: 238. 1843; Regel et Bunge, *Fl. Turkest. Icon.* 19: 1-4. 1876; Boiss. *Fl. Or.* 5: 208. 1882; Hook. f. *Fl. Brit. Ind.* 4: 355. 1892; Collett, *Fl. Simlens.* 529. 1902; Pascher in *Lotos* 24: 115. 1904 & in *Bull. Nat. Mosc.* 4: 366. 1906; Terracc. in *Soc. Bot. France Mem.* 2. ser. 4, 5: 21. 1905; Bamber, *Pl. Punj.* 499. 1916; Vved. in *Fl. Turkm.* 1(2): 268. 1932; Grossh. in Komarov, *Fl. U.S.S.R.* 4: 54. 1935.

Basionym *Ornithogalum reticulatum* Pall. *Reise* 3: 727. t. d. f. 2. 1776 (Type: U.S.S.R. — Astrakhan desert, P. S. Pallas LE, BM). *O. circinatum* Linn. *Suppl.* 199. 1781 (Type: U.S.S.R.-Astrakhan desert, Pallas LE, BM, LINN). *G. reticularis* (Pall.) Salisb. in *Kon. & Sims. Ann. Bot.* 2: 557. 1806. *G. commutata* C. Koch in *Linnaea* 22: 227. 1849 (Type: S. Russia, C. Koch B). *G. triphylla* C. Koch l.c. 229 (Type: S. Russia, C. Koch B). *G. sermantosa* C. Koch l.c. 230 (Type: S. Russia, C. Koch B). *G. pseudoreticulata* Vved. in *Fl. Turkm.* 1(2): 268. 1932 (Type: U.S.S.R.-Turkmenistan, Regel LE); Grossh. in Koma-

rov, Fl. U.S.S.R. 4: 100. 1935; Wendelb. in Koie & Reching, Symb. Afghan. 4: 160. 1958, *syn. nov.* *G. pedunculata* Wall. Cat. 5066, nom. nud. (Fig. 4).

Herbs 5-21 cm long; bulbs 4-12 x 2-6 mm, ovoid or elongated ovoid, rooting below; outer scales brown, fibrous; bulbels 1 or 2, often with leaves. *Radical leaf* 1, 5-16 cm, much longer than the stem when young, linear, terete. Stem 1-15 cm long, finely hairy, naked, linear. *Cauline leaves* 4-6, at the base of the inflorescence, linear-lanceolate, straight, not distinct from the bracts. Inflorescence terminal umbel, up to 20 flowered. *Flowers* yellow with greenish apex and green band outside, small, campanulate; pedicel 1.5-6 cm long, linear, finely hairy; bracts at the base of the inflorescence, foliaceous, up to 7 x 0.2 cm, linear, plicate. *Perianth* segments 9-15 x 1.5-2 mm, lanceolate, acute, thin; pubescent outside, scarious at margin; veins many. *Filaments* unequal, 4-6 x 0.5 mm, linear; anthers 1.5-2 x 0.5-0.7 mm, narrowly oblong. *Ovary* sessile, 2-3 x 1-1.5 mm, oblong, or obovate-oblong; style 4-5 mm, trisulcate. *Capsules* deep brown dull, \pm 6 x 3 mm, obovoid, or oblong, trigonous; pericarp thin, 6-ribbed. *Seeds* deep brown, 1 x 0.7 mm, triangular, compressed, thickly margined.

Flowering: February-April.

Fruiting: March-July.

Ecology: In soil formed from Tertiary calcium carbonate rock debris or desert silt, in gorges or beside winter torrents with grass, at an altitude of 400-2895 m.

Distribution: Desert region of S. Russia and C. Asia to Afghanistan, Pakistan and India in W. Himalaya. (Fig. 1).

Note: *G. pseudoreticulata* was distinguished from *G. reticulata* by the absence of sheathing bulb-scales below the stem. This character is variable due to ecological condition, and

does not have any taxonomic significance.

Herbarium specimens examined: INDIA: Kashmir, Gilgit, *G. M. Giles* 113 (CAL). Himachal Pradesh, Chamba, *Lace* 1884 (BSIS); Kangra, *Drummond* 1747 (K). Uttar Pradesh, Dehradun, *Gamble* 22634 (K); *P. W. Mackinon* s.n. (CAL); *Kurz* (CAL).

PAKISTAN: Kohat Pass, 23/HBK (CAL); Chitral, *Younghusband* 1594 (CAL); Kurram, *Harol Dean* (K); Peshwar, *J. H. Lace* 3499 (CAL); Lahore-Gujerat, *Baden Powell* (CAL), Rawalpindi, *R. R. Stewart* 4 (K) & *B. O. Coventry* 806 (K); Basal, 1945, *R. S. Byles* (K); Baluchistan-Afghanistan Boundary, *Surgeon Capt. F. P. Maynard* 17e (CAL); Quetta, *J. F. Duthie* 8272 (CAL, BM).

11. *G. setifolia* Baker in Journ. Linn. Soc. 18: 101. 1880 (Type: Afghanistan, Kurram valley, Alikhel, 17.4.1879, *Aitchison* 104 K — Photo!); Boiss. Fl. Or. 5: 211. 1882; Pascher in Bull. Nat. Mosc. 4: 368. 1905; Wendelb. in Koie & Reching, Symb. Afghan. 4: 160. 1958. (Fig. 4).

Herbs 8-16 cm long; bulbs 1.5-2 x 1-1.2 cm, profusely rooting below, outer scales scarious. *Radical leaf* 1, 12-16 x 0.15 cm, linear. Stem naked below, leafy at the base of the inflorescence, minutely pilose below. *Cauline leaves* many, crowded at the base of the inflorescence; lowest 3-5 x 0.3-0.4 cm, linear-lanceolate, straight, acute, sheathing; others 1-3 x 0.1-0.2 cm, linear, bract-like. *Inflorescence* umbel of 2-3 flowers, oldest on one side of the stem. *Flowers* yellow inside, green outside; pedicel 0.5-2 cm long, longest near the lowest cauline leaf; bract indistinct from cauline leaves. *Perianth* segments 15-16 x 2-3 mm, lanceolate, inner acute, outer plicate at the tip. *Filaments* 5-6 x 0.7 mm, subulate; anthers 2-3 x 0.7-1 mm, linear oblong. *Ovary* sessile, \pm 4 x 1 mm, oblong, trilocular; ovules

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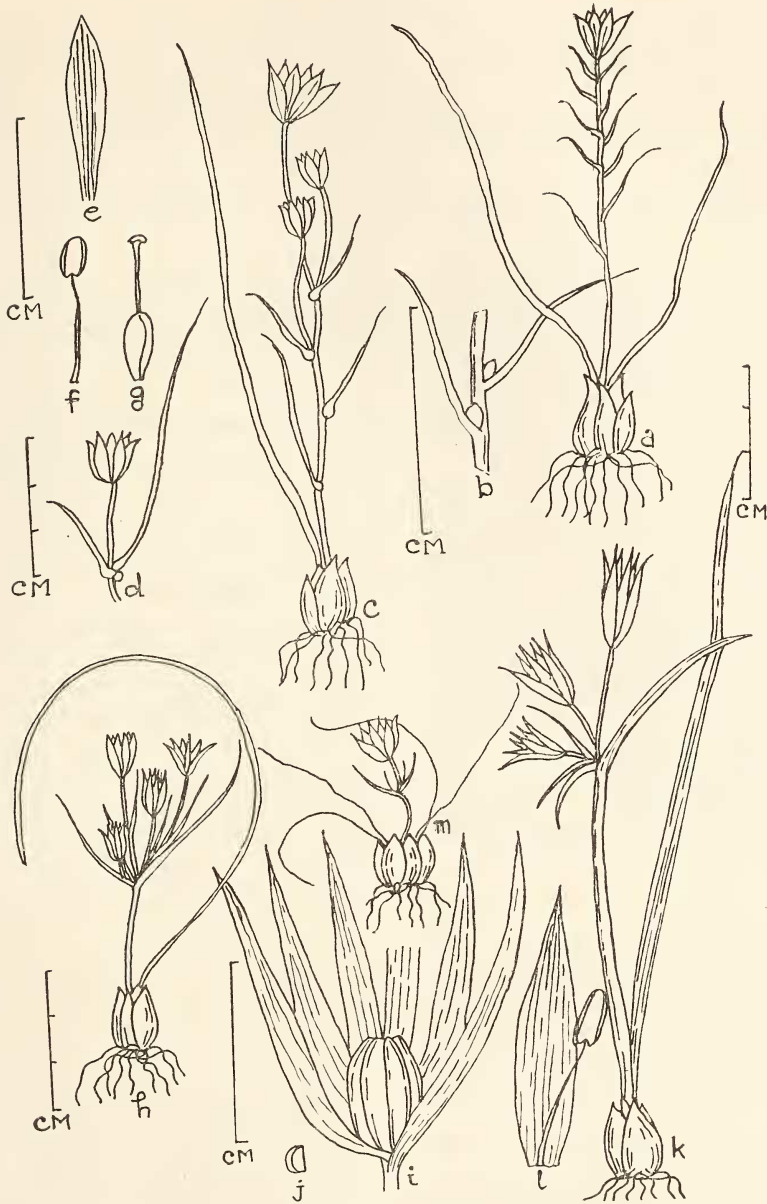


Fig. 4. *Gagea pamirica* Grossh. — a) whole plant; b) Axillary bulbils. *G. bulbifera* (Pall.) Salisb. — c) whole plant; d) bulbiferous leaf base; e) Perianth segment; f) Stamen; g) Pistil. *G. reticulata* (Pall.) Schultes f. — h) whole plant; i) capsule with persistent perianth; j) seed. *G. setifolia* Baker — k) whole plant; l) Perianth segment with a stamen. *G. chitralensis* Dasgupta & Deb — m) whole plant.

biseriate, 12-18 in each locule; style 5-6 mm long, linear; stigma 0.5 mm broad, truncate.

Flowering: April-July.

Ecology: Amongst snow-boulders at an altitude of 3960 m.

Distribution: Western Asia extending to India in Kashmir (Fig. 1).

Herbarium specimens examined: INDIA: Kashmir-Gilgit, G. M. Giles (CAL). PAKISTAN: Chitral, J. D. A. Stainton 2847 (BM).

12. **G. chitralensis** Dasgupta & Deb in *Candollea* 38: 477. 1983. Type: Pakistan, Chitral, *Bowes Lyon* 611 (BM) — Holo; Tashkent, *Vvedensky* 53 (CAL) — Para. (Fig. 4).

Herbs 2-5 cm long; bulbs 4-6 x 2-3 mm, brown, with bulbels. *Radical leaves* 4-8 x ± 0.05 cm, linear, exceeding the floral shoot. Stem small, terete, glabrous. *Cauline leaves* indistinct from the bracts. *Flower solitary*, 7-8 mm long; pedicel upto 2 cm long, filiform, glabrous; bracts 4, up to 15 x 0.7 mm, foliaceous, linear. *Perianth segments* 7-8 x 1.5-2 mm, lanceolate, glabrous, acute with 3 median veins, outer narrower, shorter. *Filaments* 4-4.5 x 0.5 mm, subulate; anthers ± 1.5 x 0.7 mm, oblong.

Ovary sessile, 3-3.5 x 0.5-0.7 mm, narrowly oblong; style ± 7.5 x 0.5 mm. *Fruit* not seen.

Flowering: March.

Distribution: S. Russia to Pakistan (Fig. 1).

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